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Yang

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(54) **CABLE ASSEMBLY HAVING A COAXIAL CABLE WITH OUTER CONDUCTOR NOT PROTRUDING A HOUSING SURROUNDING THE CABLE**

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(21) Appl. No.: **14/063,316**

(22) Filed: **Oct. 25, 2013**

(65) **Prior Publication Data**

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Related U.S. Application Data

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(51) **Int. Cl.**

H01R 9/05	(2006.01)
H01R 24/40	(2011.01)
H01R 13/648	(2006.01)

(52) **U.S. Cl.**

CPC ***H01R 9/05*** (2013.01); ***H01R 24/40*** (2013.01); *H01R 13/6485* (2013.01); *H01R 2201/20* (2013.01)

(58) **Field of Classification Search**

CPC H01R 9/05
USPC 439/578–585
See application file for complete search history.

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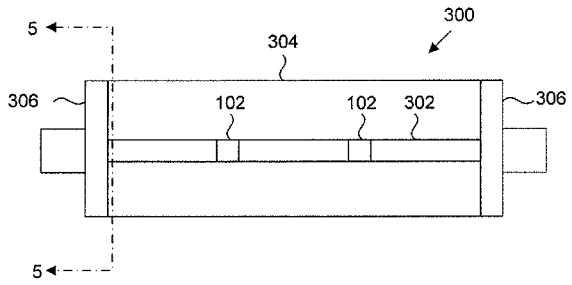
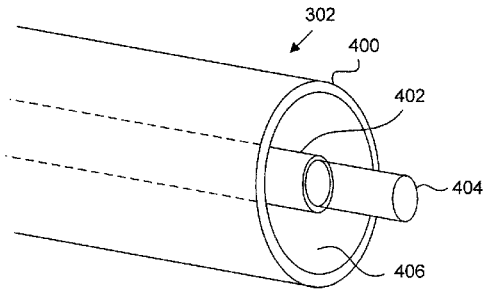
(57) **ABSTRACT**

A cable assembly including a coaxial cable having active components mounted thereon, a housing substantially surrounding the coaxial cable, and a launch connector mounted to the outside of the housing and in connection with the coaxial cable.

13 Claims, 4 Drawing Sheets





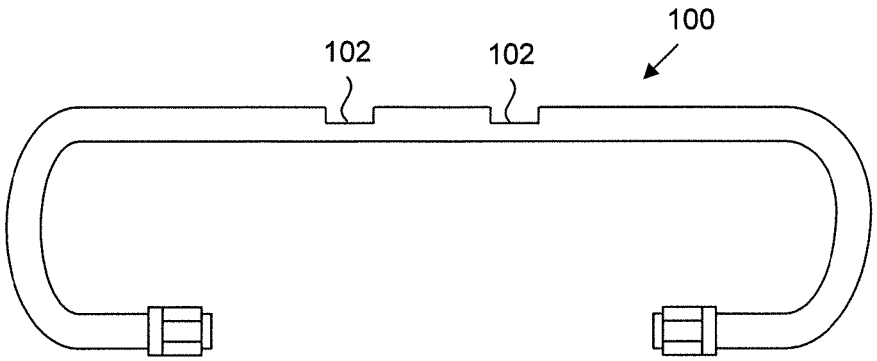


FIG. 1
PRIOR ART

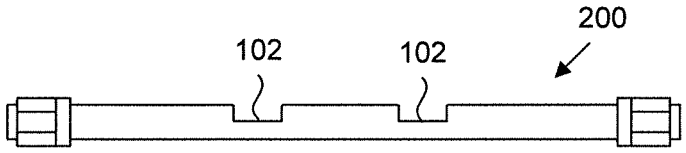


FIG. 2
PRIOR ART

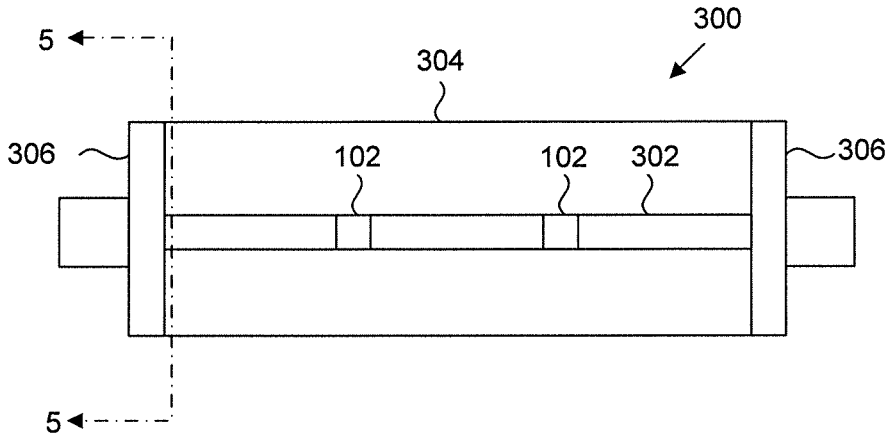


FIG. 3

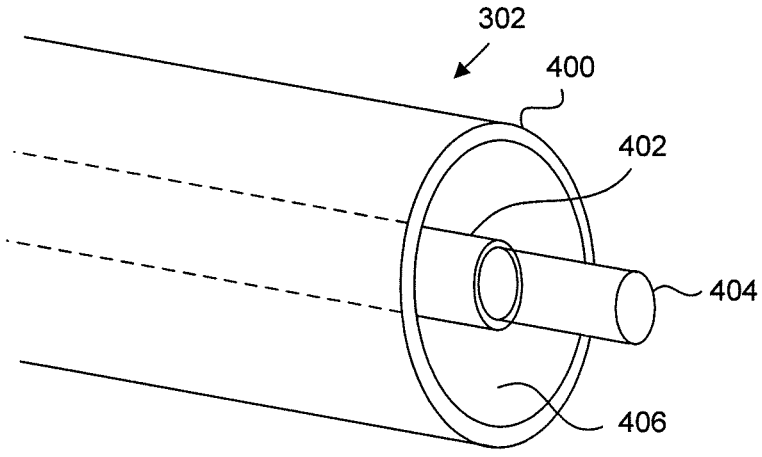


FIG. 4

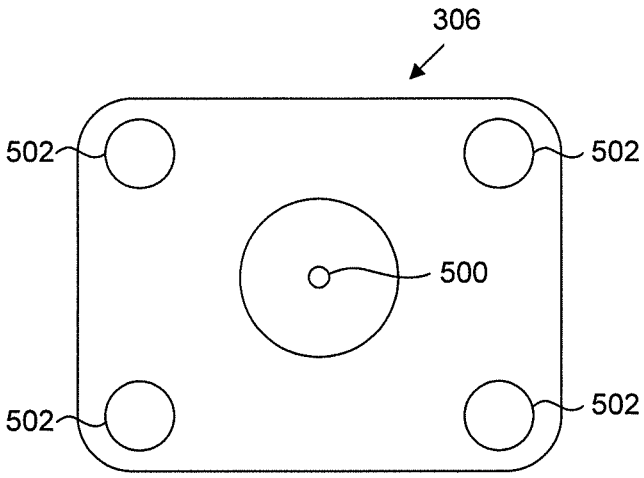


FIG. 5

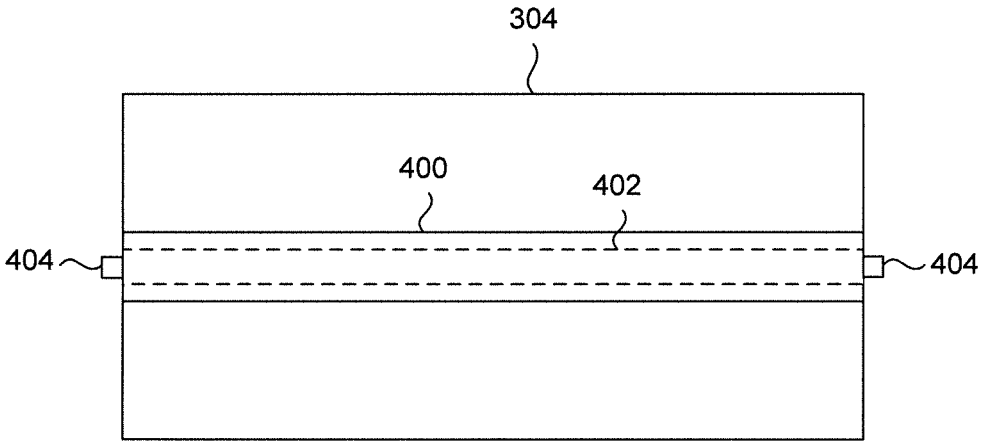


FIG. 6

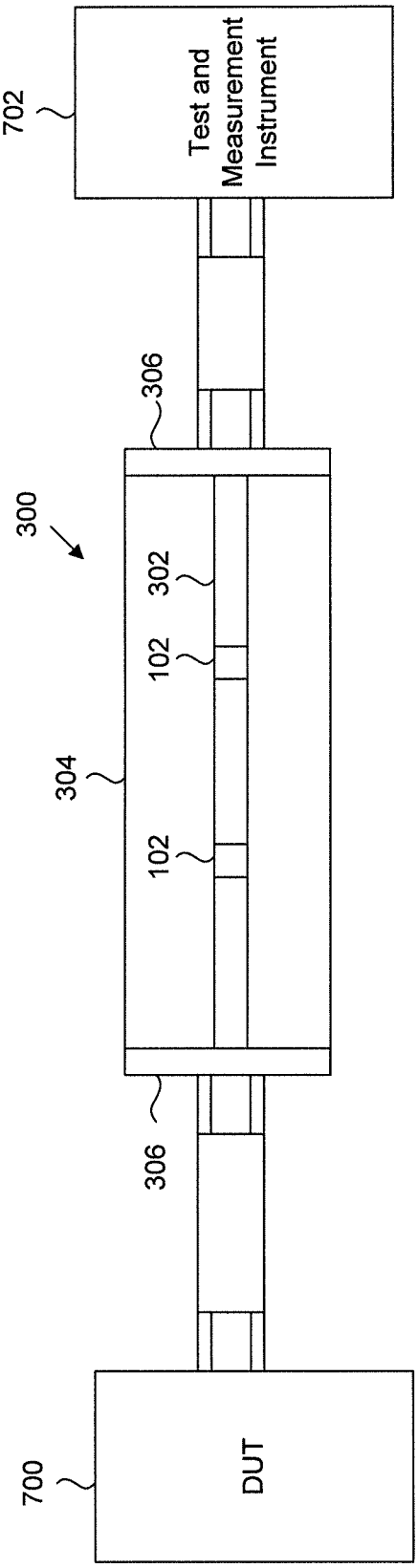

Test and Measurement Instrument
702
306
300
302
102
304
102
306
DUT
700

FIG. 7

CABLE ASSEMBLY HAVING A COAXIAL CABLE WITH OUTER CONDUCTOR NOT PROTRUDING A HOUSING SURROUNDING THE CABLE

TECHNICAL FIELD

This disclosure relates to electrical connectors and specifically concerns over high frequency small signal connectors.

BACKGROUND

It can be desirable for high frequency electrostatic damage (ESD) protectors to have short physical lengths. ESD protector solutions based on slotted semi-rigid coaxial cable structures, such as shown in FIG. **1**, can meet the required performance requirements for high frequency. When applying the structure of FIG. **1**, however, to build a short cable length design, as seen in FIG. **2**, a high failure rate was encountered during testing and handling of the short cable lengths.

The ESD protection device **100** as shown in FIG. **1** was proven effective for long semi-rigid coaxial cables. The ESD protection device **100** includes active components in active component slots **102**. When a cable is connected to the ESD protection device **100**, the inner conductor (not shown) attached to the active component does not rotate when the cable is connected due to the bend in the EDS protection device, seen in FIG. **1**.

A very high failure rate was found when the cable length was shortened and the bent section removed to fit the form factor requirements of a sampling oscilloscope product line such as an external time-domain reflectometer (TDR) module protector. The shortened ESD protection device **200** fails because the fragile active components in active component slots **102** are torn apart due to a center cable conductor of the ESD protection device **200** is rotated from its original position, which tears the active components in the active component slots **102**. A shortened cable does not have enough PTFE, or Teflon, to hold the center conductor in place. As a result, the cable center conductor will rotate along with the soldered on connector center pin as it rotated by a user. Rotation of this center conductor drags one of the attached arms of the active components in the active components slot **102** and rips them apart because each of the active components' arms are still attached to the stationary outer conductor. It turns out that center pin rotation on SMA (SubMiniature version A) style high frequency connectors has historically been a problem and troubled the industry for some time. The triggering action is that users usually often inadvertently rotate the body of the mating parts instead of just rotating the connector coupling nut as the user should when engaging the connectors. This causes the active components in the active component slots **102** to tear in the shortened ESD protection device **200**. As discussed above, the bend shown in FIG. **1** protects the inner conductor in the longer ESD protection device **100** from being rotated and damaging its installed active components.

Accordingly, a need remains for an ESD protection device **200** which is short in length and does not include the bend of the ESD protection device **100**, but that prevents tearing of the active components in the active component slots **102** when connected to a cable.

SUMMARY

Certain embodiments of the disclosed technology include a cable assembly, comprising a coaxial cable having active components mounted thereon, a housing substantially surrounding the coaxial cable, and a launch connector mounted to the outside of the housing and in connection with the coaxial cable.

Other embodiments of the disclose technology include a system, comprising a device under test; a test and measurement instrument; and a cable assembly. The cable assembly includes a coaxial cable having active components mounted thereon; a housing substantially surrounding the coaxial cable; and two launch connectors mounted to the outside of the housing and in connection with the coaxial cable. One of the launch connectors attaches the cable assembly to the device under test and the other launch connector attaches the cable assembly to the test and measurement instrument.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** illustrates a prior art ESD protection device.

FIG. **2** illustrates another prior art ESD protection device.

FIG. **3** illustrates a top view of a cable assembly of the disclosed technology.

FIG. **4** illustrates the conductor of FIG. **3**.

FIG. **5** illustrates an end view of a launch connector along lines **5-5** in FIG. **3**.

FIG. **6** illustrates the conductor of FIG. **4** within the housing of FIG. **3**.

FIG. **7** illustrates a system using the cable assembly of FIG. **3**.

DETAILED DESCRIPTION

In the drawings, which are not necessarily to scale, like or corresponding elements of the disclosed systems and methods are denoted by the same reference numerals.

The disclosed technology relates to a special technique to incorporate a slip joint between a launch connector pin receptacle and an inner conductor of a coaxial cable so that rotation of a center pin of the launch connectors does not result in rotation of the inner conductor of the coaxial cable. The coaxial cable includes parallel mounted fragile active components in the active component slots **102**. The fragile active components in the active component slots **102** may be, for example, diodes (not shown).

In the disclosed technology, instead of using a solder on connector like typical coaxial cables do, a cable assembly **300** is divided into three sections. The cable assembly **300**, as shown in FIG. **3**, includes a coaxial cable **302** located within a housing **304**. Attached to the housing **304** are two launch connectors **306**. The launch connectors **306** attach the cable assembly **300** to other cables which may be connected to a device or a test and measurement instrument.

Preferably, the launch connectors **306** are standard edge launch connectors, such as 2.4 mm connectors sold by Southwest Microwave, Inc. Launch connectors **306** used in the disclosed technology are preferably launch connectors designed for microwave transmission from a coaxial cable environment to a stripline or micro strip line. Any launch connection, however, may be used. Launch connectors usually have various diameter launch pins available. In the disclosed technology, however, the launch pins are not used with the launch connector **306**, as will be described more fully below. The launch connector **306** does not have to take the shape of that shown in FIGS. **3** and **5**. For example, a narrower two hole mounting launch connector **306** may be used. Any launch connector that has a launch pin receptacle, as discussed more fully below, may be used.

The coaxial cable **302**, shown in more detail in FIG. **4**, includes an outer conductor **400**, an inner conductor with two

portions **402** and **404**, and a dielectric layer **406**. A portion of the inner conductor **402** is located within the housing **304** (hereinafter inner portion of the inner conductor **402**) and a portion of the inner conductor **404** is located outside the house (hereinafter the outer portion of the inner conductor **404**), as will be discussed in more detail below with respect to FIG. **6**. FIG. **4** shows one end of the coaxial cable **302**. Although not shown, the opposite end of the cable would have the same configuration as shown in FIG. **2**. Preferably the coaxial cable **302** is a low loss 0.086 inch diameter semi-rigid coaxial cable. Any coaxial cable, however, may be used.

The portion of the inner conductor **404** located outside the housing fits inside the launch pin receptacle **500** of the launch connector **306**, shown in FIG. **5**, where normally a launch pin would be inserted. This allows the radio frequency signal to travel from the launch connector **306** into the cable assembly **300** or from the cable assembly **300** to the launch connector **306**. The length of the inner conductor **404** allows for the inner conductor **404** to extend out from the housing **304** outer wall just enough to mate with the launch pin receptacle **500** without bottoming out. The housing **304** discussed above maintains transmission line integrity. Further, the housing **304** holds and aligns the coaxial cable **302** to the launch connectors **306**. That is, the launch connectors **306** are screwed onto the housing **304** via holes **502** in the launch connector **306**. The housing **304** must have a very accurate dimensional control so that the outer portion of the inner conductor **404** is outside the housing **304**, as described above and in further detail below.

As shown in FIG. **6**, the outer conductor **400** of the coaxial cable is dimensioned to be the exact length of the housing **304**. The outer portion of the inner conductor **404** is dimensioned to extend beyond an outer wall of the housing **304** by approximately 0.045 inches. The inner portion of the inner conductor **402**, however, is dimensioned to be the exact length of the housing **304** and the outer conductor **400**. That is, the outer portion of the inner conductor **404** extends beyond the housing **306**. The inner portion of the inner conductor **402** located within the housing **304** has a diameter preferably approximately 0.022 inches. The diameter of the portion of the inner conductor **404** located outside the housing is reduced to 0.018 inches. Further, the portion of the inner conductor **404** located outside the housing may be beveled. The beveling helps fit the outer portion of the inner conductor **404** into the launch pin receptacle **500** of the launch connector **306**.

When a cable, such as an SMA cable, is attached to the cable assembly **300**, the cable's connecting nut is screwed on to the launch connector **306**. Because the inner conductor **402** and **404** is located within the launch pin receptacle **500** of the launch connector **306**, the inner conductor **402** and **404** can rotate freely relative to the launch pin receptacle **500** and not follow the rotational movement of the launch pin receptacle **500**. This prevents the inner conductor **402** and **404** from rotating separately from the outer conductor **400** which in turn prevents the fragile active components in active component slots **102** on the coaxial cable **302** from tearing when the cable assembly **300** is attached to another mating connector of a cable or an instrument. That is, the launch pin receptacle **500** of the launch connector **306** and the inner conductor **402** and **404** of the coaxial cable **302** can rotate separately from each other.

The inner conductor **404** located outside the housing is plated with at least 30 micro inches thick gold and a **50** micro inches nickel barrier under the gold. Further, the end portions of the outer conductor **302** are also plated as well with at least 30 micro inches thick gold and a **50** micro inches nickel barrier under the gold. This plating ensures that while the exact contacting point is slipping along between the launch pin receptacle **500** and the inner conductor **404**, a reliable low resistance path is always maintained between the two bodies. High frequency ESD protectors built with this slip joint comprised of the cable assembly **300** and the launch connectors **306** have proven to be reliable in maintaining good electrical contacts and very effective in suppressing tearing failures of the active components within the active component slot **102**.

Although the housing has been substantially in a rectangular shape, one of ordinary skill in the art will understand that the housing can take on other shapes as well, such as cylindrical.

FIG. **7** illustrates a system in which an ESD protector built using the design of cable assembly **300** is used to protect a test and measurement instrument **702**, such as an oscilloscope, while measuring a device under test **700**. One of the launch connectors **306** attaches to a cable that leads to the device under test **700**. The other launch connector **306** attaches to the test and measurement instrument **702**. This allows high frequency measurement to be carried out safely without risk of ESD damages to the test and measurement instrument. The cable assembly shown in FIG. **7** uses the same cable assembly **300** discussed above with respect to FIGS. **3**-**6**.

Having described and illustrated the principles of the disclosed technology in a preferred embodiment thereof, it should be apparent that the disclosed technology can be modified in arrangement and detail without departing from such principles. We claim all modifications and variations coming within the spirit and scope of the following claims.

What is claimed is:

1. A cable assembly, comprising;

a coaxial cable, having active components mounted thereon, including an inner conductor and an outer conductor;

a housing substantially surrounding the coaxial cable, wherein the outer conductor does not protrude beyond the housing; and

a launch connector mounted to the outside of the housing and in connection with the coaxial cable.

2. The cable assembly of claim **1**, wherein the outer conductor is connected to ground.

3. The cable assembly of claim **1**, wherein a portion of the inner conductor extends beyond an outer wall of the housing and connects to a connector receptacle of the launch connector.

4. The cable assembly of claim **3**, wherein the inner conductor extends beyond the outer wall of the housing by approximately 0.045 inches.

5. The cable assembly of claim **3**, wherein at least 30 micro inches thick gold with a 50 micro inches nickel barrier layer underneath is plated onto the portion of the inner conductor that extends beyond the outer wall of the housing as well as around the outer conductor near the edge.

6. The cable assembly of claim **3**, wherein the inner conductor has a diameter of approximately 0.022 inches inside the housing and a diameter of approximately 0.018 inches outside the housing.

7. The cable assembly of claim **3**, wherein the portion of the inner conductor that extends beyond the outer wall of the housing is beveled.

8. The cable assembly of claim **1**, wherein the cable is a low loss 0.086 inch diameter semi-rigid coaxial cable.

9. A system, comprising:

a device under test;

a test and measurement instrument; and

a cable assembly, including:

a coaxial cable, having active components mounted thereon, including an inner conductor and an outer conductor;

a housing substantially surrounding the coaxial cable, wherein the outer conductor does not protrude beyond the housing; and

two launch connectors mounted to the outside of the housing and in connection with the coaxial cable,

wherein one of the launch connectors attaches the cable assembly to the device under test and the other launch connector attaches the cable assembly to the test and measurement instrument.

10. The system of claim **9**, wherein the outer conductor is connected to ground and is only as long as the length of the housing.

11. The system of claim **9**, wherein a portion of the inner conductor extends beyond an outer wall of the housing and connects to a connector receptacle of the launch connector.

12. The system of claim **11**, wherein the inner conductor extends beyond the outer wall of the housing by approximately 0.045 inches.

13. The system of claim **11**, wherein the inner conductor has a diameter of approximately 0.022 inches inside the housing and a diameter of approximately 0.018 inches outside the housing.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 9,099,791 B2
APPLICATION NO. : 14/063316
DATED : August 4, 2015
INVENTOR(S) : Kei-Wean C. Yang

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In the Claims

In column 5, lines 14-15, delete "and is only as long as the length of the housing"

Signed and Sealed this
Fifteenth Day of March, 2016

Michelle K. Lee

Michelle K. Lee
Director of the United States Patent and Trademark Office